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(54) Title: AUTOMOTIVE WHITE OIL-BASED LUBRICANT COMPOSITION (57) Abstract An automotive lubricant composition comprises a white oil basestock and at least one polyisoalkylene compound. The polyisoalkylene, e.g., polyisobutylene, acts as an antioxidant. The lubricant is used, for example, as an engine oil, gear oil or automatic transmission fluid. The lubricant may contain one or more additional antioxidants and other lubricant additives.		

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AUTOMOTIVE WHITE OIL-BASED LUBRICANT COMPOSITION

The present invention relates to automotive lubricant compositions based on white oil, and especially to automotive lubricants such as engine oils, gear oils and automatic transmission fluids.

Traditionally automotive lubricants have been based on conventional mineral oils. Whilst these have proved adequate in the past, mineral oil basestocks cannot always meet the increasing demands for superior lubricant properties, especially operational lifetime. These improved properties can be achieved to some extent by the use of additives, but research has also been conducted into modifying or changing the basestocks. In recent years lubricant manufacturers have produced automotive lubricants based on synthetic basestocks, for example polyalphaolefins and esters. Whilst these provide improved performance, they have the disadvantage that they are expensive.

There is therefore a need for an automotive lubricant with an alternative, less expensive basestock which provides improved properties.

Our co-pending patent application PCT EP93/00231 filed 1 February 1993 describes an automotive lubricant composition comprising a basestock of which at least 30 wt.% is a white oil basestock and at least one antioxidant additive. Other, conventional, lubricant additives may also be included. This white oil-based lubricant has the advantage that it exhibits better oxidation stability than comparative mineral-based lubricants, but is less expensive than comparative synthetic-based lubricants.

The present invention relates to a further improvement in the oxidation stability of white oil-based automotive lubricants.

In one aspect, the present invention provides an automotive lubricant composition comprising a white oil-containing basestock and at least one polyisoalkylene compound.

In another aspect, the present invention provides a method of providing or enhancing protection against oxidation of a lubricating oil (e.g., a white oil-containing lubricating oil) by adding to, or incorporating in, the lubricating oil, at least one polyisoalkylene compound.

In another aspect, the invention provides a method of operating automotive equipment selected from one or more items chosen from an internal combustion engine, a gearbox, an automatic transmission, the method comprising lubricating the said equipment with an automotive lubricating composition comprising a white-oil containing basestock and at least one polyisoalkylene compound.

Polyisoalkylenes such as polyisobutylene are known for use as thickeners to increase the viscosity of lubricants based on conventionally refined mineral oils. We have found, surprisingly, that when polyisoalkylene is added to a white oil-based lubricant it has the effect of improving its oxidation stability so that the resulting polyisoalkylene-containing white oil-based lubricant can be employed as an automotive lubricant. Polyisoalkylenes have not previously been proposed or used as anti-oxidants. Thus the resulting automotive lubricant of the invention has the benefit of increased efficacious operation times, i.e. it can be used to lubricate an automotive mechanical device, for example an internal combustion engine or gear box or automotive transmission for an extended period before it requires replacing. In some applications the lubricant can be used as a fill-for-life lubricant, i.e. the operational life-time of the lubricant matches or exceeds that of the mechanical part it is lubricating.

The white oil used as the base oil for the lubricant of the present invention may be a white oil obtained by solvent extraction of a lubricant basestock feed and hydrogenation of the resulting raffinate in one or more hydrogenation stages to produce a white oil lubricant basestock which is virtually free of sulphur and nitrogen. White oils are defined in the "Food and Drug Administration Code of Federal Regulation", 1991. Either medicinal white oils according to specification FDA 21 CFR 178-3620 (a) or

technical white oils according to specification FDA CFR 178-3620 (b) may be employed in the present invention.

Preferably the white oil is highly naphthenic. It has been found that white oils with a relatively high naphthenic content exhibit improved properties compared with more paraffinic white oils. Preferably the white oil, used in the present invention has a naphthenic content of at least 25 wt.%, where 'naphthenic content' is defined as the amount of naphthenic carbon as a percentage of the total carbon content of the white oil, according to standard test ASTM D 2140. More preferably the naphthenic content of the white oil is from 30 to 50 wt.%, more preferably 30 to 40 wt.%. A highly naphthenic white oil is obtained by using mild hydrogenation conditions, so that the cyclic molecules contained in the oil are not substantially broken. Typical mild hydrogenation conditions are a temperature in the range of from 150 to 250°C, and a pressure in the range of from 1000 to 20,000 kPa, e.g., about 4,000 kPa. A method of making a suitable white oil is described in patent GB-A-1597165, the disclosures of which form part of the disclosure in the present patent application.

In a preferred method of making the white oil basestock, a lubricating oil basestock is subjected to solvent extraction with a solvent having an affinity for aromatic hydrocarbons. Suitable solvents for this purpose include N-methylpyrrolidone, phenol, furfural, and sulfur dioxide (inter alia). The aromatics-depleted raffinate is then subjected to hydrogenation treatment in the presence of a suitable hydrogenation-promoting catalyst such as Ni-W on an alumina-containing support. The resulting hydrogenated raffinate is stabilised within the desired lubricating oil boiling range, and is then a white oil suitable for use in the present invention. There is not usually any requirement to dewax the white oil (or its precursors during manufacture). The solvent extraction may be so performed that no more than 7% aromatics remains in the raffinate.

The white oil product, as described, may be subjected to a second hydrogenation stage under the same or similar conditions to those used in the first stage (e.g., 150 to 250°C temperature range, 1000 to 20,000 kPa pressure range) in order to convert its

quality from technical grade white oil to pharmaceutical grade quality. White oils produced by the method described are highly naphthenic. However, highly naphthenic white oils can be made by other methods, as will be known by those skilled in the art. In the present invention, both technical and pharmaceutical grades of white oil may be employed. The pharmaceutical grade is more expensive, but has the benefit that, when blended with polyisoalkylene and optionally other additives, the resulting automotive lubricating composition has greater oxidation stability than a similar blend based on technical white oil. The oxidation stability of white oils and oil compositions containing white oils is generally poor. It is therefore considerably surprising that compositions of polyisoalkylene compounds and either white oils or oil compositions containing white oils have such outstandingly good oxidation stability.

The naphthenic composition of preferred highly naphthenic white oils advantageously used in the present invention is preferably as follows, the measurements being obtained using standard test method ASTM D 2786 :

- 1 ring : 20-30 wt.%, preferably 24-32 wt.%
- 2 rings : 13-27 wt.%, preferably 17-23 wt.%
- 3 rings : 4-21-wt.%, preferably 8-17 wt.%
- 4 rings : 3-19 wt.%, preferably 7-15 wt.%
- 5 rings or more : 0-9 wt.%, preferably 2-5 wt.%

Commercially-available examples of suitable FDA regulation food grade quality white oils that can be used in the present invention include MARCOL 52 - naphthenic content 34%, MARCOL 82 - naphthenic content 32%, MARCOL 172 - naphthenic content 34%, PRIMOL 352 - naphthenic content 32%, and PLASTOL 352 - naphthenic content 32%, all supplied by Exxon/Esso. Examples of suitable FDA regulation technical grade white oils that can be used in the present invention include BAYOL 52 - naphthenic content 34% and PLASTOL 135 - naphthenic content 36%, both supplied by Exxon/Esso. MARCOL, PRIMOL, PLASTOL and BAYOL are trade marks of Exxon Corporation. The naphthenic content is measured according to standard test method ASTM 2140.

The basestock may comprise 100% white oil, or it may comprise a blend or composition of white oil with one or more other types of oil, for example conventional mineral oil, a synthetic oil such as a polyalphaolefin or an ester such as a polyol ester or diester, a hydrocracked basestock, a hydroisomerised basestock, or a mixture of two or more thereof. If the basestock is a blend, the preferred proportion of white oil in the basestock is at least 30 wt.%, more preferably between 30 and 60 wt.%.

The polyisoalkylene is preferably a low molecular weight polymer, for example in the range from 400 to 50,000 more preferably 500 to 30,000, most preferably 800 to 10,000. A low molecular weight polymer is beneficial because it tends not to shear under stress and retains its viscosity in use.

Preferably the alkylene group of the polyisoalkylene contains from 3 to 10 carbon atoms, more preferably from 3 to 6. Most preferred is polyisobutylene.

The polyisobutylene may be the sole antioxidant additive in the lubricant or it may be combined with one or more other antioxidant additives. Where another antioxidant is included this may be selected from conventional lubricant antioxidant additives, such as for example, aminic antioxidants, e.g. diphenylamines; hindered phenols; sulphurised phenols; phospho-sulphurised alkylphenols; dithiophosphates, e.g. zinc dialkyl dithiophosphate, zinc diaryl dithiophosphate, zinc alkylaryl dithiophosphate and ashless thiophosphate compounds, dimercapto dithiodiazole; alkyl phenol sulphides; alkyl thiocarbamates such as zinc alkyl dithiocarbamates; and copper-based antioxidants. Preferably this other antioxidant is aminic.

The amount of polyisoalkylene included in the lubricant composition is typically from 0.5 to 50 wt.% based on the total weight of the lubricant composition, preferably from 2 to 20 wt.%, more preferably from 5 to 15 wt.%.

Where another antioxidant is included, this is typically in an amount from 0.1 to 5 wt.% based on the total weight of the lubricant composition, preferably 0.5 to 2 wt.%.

The automotive lubricant composition of the invention may also contain other additives such as those typically contained in an engine oil, gear oil or automotive transmission fluid as appropriate. These include detergents, for example alkaline earth metal sulphonates, calcium salicylates, alkaline earth metal sulphurised phenates; ashless dispersants, for example polyisobutenesuccinimide, anti-wear/extreme pressure agents, for example zinc dialkyl (or diaryl or arylalkyl) dithiophosphate, or phosphorus and/or sulphur and/or borated compounds; anti-corrosion agents, for example barium alkylnaphthalene sulphonates or mercaptobenzotriazole; viscosity improvers other than and/or in addition to the said polyisoalkylene, for example olefin copolymers, polyalphaolefins, polymethacrylates or styrene butadiene; pour point depressants, for example polyesters or polymethacrylates; anti-foam agents, for example those based on silicones; and friction modifiers, for example molybdenum compounds, ashless compounds and anti-squawk agents. For each additive, the amount included in the automotive lubricant may be selected depending upon the type of additive and the intended application of the lubricant, and the appropriate amount would be readily determined by a person skilled in the art. Some or all of the additives may be incorporated into the automotive lubricant by means of an addpack.

Whilst the lubricant composition according to the invention may be used for other applications, it is especially suitable for use as an automotive lubricant including gear oils, automatic transmission fluids and engine oils.

In general terms, the automotive lubricant composition according to the invention has a viscosity in the range of from 4 to 50 mm²/s at 100°C, and a viscosity index in the range of from 80 to 200. More specifically, where the lubricant is an engine oil, it preferably has a viscosity of from 4 to 35 mm²/s, more preferably from 5 to 25 mm²/s, at 100°C, and a viscosity index of from 85 to 160, more preferably from 95 to 150. Where the lubricant is a gear oil, it preferably has a viscosity of from 5 to 50 mm²/s, more preferably from 8 to 25 mm²/s, at 100°C, and a viscosity index of from 80 to 180, more preferably from 95 to 160. Where the lubricant is an automatic transmission fluid, it preferably has a viscosity of from 4 to 10 mm²/s, more preferably from 5 to 8 mm²/s, at 100°C, and a viscosity index of from 100 to 200, more preferably from 150 to 200.

The invention is now illustrated by the following Examples :

Example 1

Two white oil-based gear oils were formulated as follows :-

<u>Component</u>	<u>Example 1A - Invention (wt.%)</u>	<u>Example 1B - Comparative (wt.%)</u>
PRIMOL 352 ¹	80.55	89.55
PIB ²	9.00	-
IRGANOX L-57 ³	0.95	0.95
Addpack ⁴	8.50	8.50
Pour point depressant	1.00	1.00

- 1 - White oil basestock available from Esso S.A.F., France.
- 2 - Polyisobutylene having a molecular weight of 950.
- 3 - An aminic antioxidant available from Ciba-Geigy.
- 4 - A standard gear oil additive package.
- 5 - A polymethacrylate pour point depressant.

The two formulations were identical in every respect except that Example 1A contained 9.00 wt.% polyisobutylene and a correspondingly smaller amount of basestock.

The formulations were tested for oxidative stability according to GFC standard test T 021 A 90 carried out at 160°C. This test measures the change in viscosity of the gear oil at 40°C (KV 40) and at 100°C (KV 100) over a test period of 192 hours. The smaller the increase in KV 100, the better the oxidative stability of the gear oil. The results are given in Tables 1 and 2 below.

Example 2

Two white oil-based gear oils were formulated as follows :-

<u>Component</u>	<u>Example 2A - Invention (wt.%)</u>	<u>Example 2B - Comparative (wt.%)</u>
MARCOL 82 ¹	80.55	89.55
PIB ²	9.00	-
IRGANOX L-57 ³	0.95	0.95
Addpack ⁴	8.50	8.50
Pour point depressant	1.00	1.00

- 1 - White oil basestock available from Esso S.A.F., France.
- 2 - Polyisobutylene having a molecular weight of 950.
- 3 - An aminic antioxidant available from Ciba-Geigy.
- 4 - A standard gear oil additive package.
- 5 - A polymethacrylate pour point depressant..

Again, the two formulations were identical in every respect except that Example 2A contained 9.00 wt.% polyisobutylene and a correspondingly smaller amount of basestock. The formulations were tested for oxidative stability as described in Example 1, and the results are given in Table 1 below.

Table 1

Time (hours)	KV 40 (mm ² /s)			
	<u>Example 1A</u>	<u>Example 1B</u>	<u>Example 2A</u>	<u>Example 2B</u>
0	96.83	68.87	26.06	17.71
96	150.4	151.4	39.61	49.30
144	163.4	174.4	43.69	64.56
192	175.3	160.9	50.30	64.84
KV increase (%)	81.0	133.6	93.0	266.1

Table 2

Time (hours)	KV 100 (mm ² /s)			
	<u>Example 1A</u>	<u>Example 1B</u>	<u>Example 2A</u>	<u>Example 2B</u>
0	11.44	9.18	5.10	3.93
96	16.05	18.93	6.94	10.35
144	17.32	19.70	7.68	12.12
192	18.42	18.80	8.51	11.98
KV increase (%)	61.0	104.8	66.0	204.8

Examples 1A and 2A referring to white oil compositions containing polyisobutylene demonstrate significantly smaller increases in KV 40 and KV 100, thus showing that oil formulations according to the invention exhibit greatly superior stability.

The results in Tables 1 and 2 show that white oil lubricant formulations have superior stability when they contain polyisobutylene.

Example 3

Five gear oils having a white oil basestock were formulated as follows, using the same components as in the previous examples. All proportions are in weight percent.

<u>Component</u>	<u>Example 3A</u> <u>(comparative)</u>	<u>Example 3B</u> <u>(invention)</u>	<u>Example 3C</u> <u>(invention)</u>	<u>Example 3D</u> <u>(invention)</u>	<u>Example E</u> <u>(invention)</u>
MARCOL 82	89.5	86.5	80.5	69.5	39.5
PIB	.	3.0	9.0	20.0	50.0
IRGANOX L-57	1.0	1.0	0.95	1.0	1.0
Addpack	8.5	8.5	8.5	8.5	8.5
Pour point depressant	1.0	1.0	1.0	1.0	1.0

The five gear oils were subjected to the standard oxidative stability test GFC T 021 A 90 at 160°C up to 192 hours. The test results are given in Tables 3 and 4.

The results in Tables 3 and 4 suggest that the improvement in oxidative stability conferred by the presence of polyisoalkylene in the specific formulations of Example 3 is generally greater when the concentration of polyisoalkylene exceeds 3 wt.%. At concentrations above 20 wt.%, the oxidative stability is significant, but tends to reduce at a concentration of 50 wt.%. The optimum concentration range seems to be between 3 wt.% and 20 wt.%, e.g. 5 to 15 wt.%, preferably from 8 to 12 wt.% (e.g., about 10 wt.%).

Table 3

Time (hours)	KV 40 (mm ² s)				
	<u>Example 3A</u>	<u>Example 3B</u>	<u>Example 3C</u>	<u>Example 3D</u>	<u>Example 3E</u>
0	15.99	18.00	26.06	39.43	227.2
192	84.0	111.0	50.3	10.2	95.2
KV 40 Increase %	425	517	93	159	319

Table 4

Time (hours)	KV 100 (mm ² s)				
	<u>Example 3A</u>	<u>Example 3B</u>	<u>Example 3C</u>	<u>Example 3D</u>	<u>Example 3E</u>
0	3.66	3.96	5.10	6.69	20.15
192	13.0	16.6	8.51	13.5	56.4
KV 100 Increase %	257	320	66.0	101	180

CLAIMS:

1. An automotive lubricant composition comprising:
 - (a) a basestock comprising white oil, and
 - (b) at least one polyisobutylene compound.
2. A lubricant composition according to claim 1 wherein the polyisoalkylene has a molecular weight of from 400 to 50,000.
3. A lubricant composition according to claim 1 or 2 wherein the alkylene group in the polyisoalkylene contains from 3 to 10 carbon atoms.
4. A lubricant composition according to claim 3 wherein the polyisoalkylene is polyisobutylene.
5. A lubricant composition according to any preceding claim wherein the amount of basestock is from 50 to 95.5 weight percent and the amount of polyisoalkylene is from 0.5 to 50 weight percent, (e.g., from 5 to 20 weight percent) based on the total weight of the lubricant composition.
6. A lubricant composition according to any preceding claim which contains from 0.1 to 5 weight percent of an antioxidant additive in addition to, and other than, the polyisoalkylene.
7. A lubricant composition according to claim 6 wherein the other antioxidant additive is selected from aminic antioxidants, e.g. diphenylamines; hindered phenols; sulphurised phenols; phospho-sulphurised alkylphenols; dithiophosphates, e.g. zinc dialkyl dithiophosphate, zinc diaryl dithiophosphate, zinc alkylaryl dithiophosphate and ashless thiophosphate compounds, dimercapto dithiodiazole; alkyl phenol sulphides; alkyl thiocarbamates such as zinc alkyl dithiocarbamates; and copper-based antioxidants.

8. A lubricant composition according to any preceding claim having a viscosity at 100°C in the range of from 4 to 50 mm²/s and a viscosity index in the range of from 80 to 200.

9. A lubricant composition according to any preceding claim which is a gear oil, automatic transmission fluid or an engine oil.

10. A lubricant composition as in any preceding claim comprising one or more additives selected from detergents, dispersants, anti-wear agents, extreme pressure agents, anti-corrosion agents, viscosity improvers (other than said polyisoalkylene compound), pour point depressants, anti-foam agents, friction modifiers, anti-squawk agents.

11. A method of operating automotive equipment selected from one or more of an internal combustion engine, a gearbox and an automatic transmission, the method comprising lubricating the said equipment with an automotive lubricating composition according to any one of claims 1 to 10.

12. Use of polyisoalkylene in an automotive lubricant composition (e.g., a white oil-containing lubricating oil composition) as an antioxidant.

13. A method of providing or enhancing protection of a lubricating oil (e.g., a white oil-containing lubricating oil) against oxidation, the method comprising adding to or incorporating with the lubricating oil a polyisoalkylene compound.

AMENDED CLAIMS

[received by the International Bureau on 29 December 1994 (29.12.94);
original claims 1-13 replaced by new claims 1-10 (3 pages)]

1. An automotive lubricant oil composition or automotive fluid composition for use in an automotive engine or automotive gearbox or automotive automatic transmission, said composition comprising the following components:

- (a) a basestock comprising at least 30 wt.% of white oil;
- (b) as an anti-oxidant, from 5 to 50 wt.% of polyisoalkylene having a molecular weight in the range of from 400 to 30,000;
- (c) one or more additional additives selected from detergents, dispersants, anti-wear agents, extreme-pressure agents, anti-corrosion agents, pour point depressants, anti-foam agents, friction modifiers, anti-squawk agents, viscosity improvers (other than the said polyisoalkylene of component (b)) and 0.1 to 5 wt.% of another anti-oxidant selected from aminic anti-oxidants, dithiophosphates, dimercapto-dithiodiazoles, alkylphenol sulfides, alkylthiocarbamates and copper-based anti-oxidants;

the automotive oil composition or automotive fluid composition having a viscosity in the range of from 4 to 50 mm²/s at 100°C and a viscosity index in the range of from 80 to 200.

2. A lubricant composition according to claim 1 wherein the alkylene group in the polyisoalkylene contains from 3 to 10 carbon atoms.

3. A lubricant composition according to claim 2 wherein the polyisoalkylene is polyisobutylene.

4. A lubricant composition according to any one of claims 1 to 3 wherein the amount of basestock is in the range of from 50 to 95.5 weight percent and the amount of polyisoalkylene is in the range of from 0.5 to 50 weight percent, (e.g., from 5 to 20 weight percent) based on the total weight of the lubricant composition.

5. A lubricant composition according to any one of claims 1 to 4 wherein the said other antioxidant additive of component (d) is selected from aminic antioxidants, e.g. diphenylamines; hindered phenols; sulphurised phenols; phospho-sulphurised alkylphenols; dithiophosphates, e.g. zinc dialkyl dithiophosphate, zinc diaryldithiophosphate, zinc alkylaryl dithiophosphate and ashless thiophosphate compounds, dimercapto dithiodiazole; alkyl phenol sulphides; alkyl thiocarbamates such as zinc alkyl dithiocarbamates; and copper-based antioxidants.

6. A lubricant composition according to any one of claims 1 to 5 which is an automotive gear oil, an automotive automatic transmission fluid or an automotive engine oil.

7. A lubricant composition as in claim 6 having one of the following ranges of properties:

- (i) automotive engine oil composition : viscosity in the range of from 4 to 35 mm^2/s at 100°C and a viscosity index in the range of from 85 to 160;
- (ii) automotive gear oil : viscosity in the range of from 5 to 50 mm^2/s at 100°C and a viscosity index in the range of from 80 to 180;
- (iii) automotive automatic transmission fluid : viscosity in the range of from 4 to 10 mm^2/s at 100°C and a viscosity index in the range of from 100 to 200.

8. A method of operating automotive equipment selected from one or more of an internal combustion engine, a gearbox and an automatic transmission, the method comprising lubricating the said equipment with an automotive lubricating oil composition according to any one of claims 1 to 7.

9. Use of polyisoalkylene of molecular weight 400 to 30,000 as an antioxidant in an automotive lubricant oil composition or an automotive fluid composition (e.g., a white oil-containing lubricating oil composition) having a viscosity in the range of from 4 to 50 mm^2/s at 100°C and a viscosity index in the range of from 80 to 200 for use

in an automotive engine or in an automotive gearbox or as an automotive automatic transmission.

10. A method of providing or enhancing protection against oxidation of an automotive fluid composition or an automotive lubricating oil (e.g., a white oil-containing lubricating oil) having a viscosity in the range of from 4 to 50 mm²/s at 100°C and a viscosity index in the range of from 80 to 200, the method comprising adding to or incorporating with the lubricating oil a polyisoalkylene compound having a molecular weight in the range of from 400 to 30,000.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 94/02829

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 C10M169/04 //(C10M169/04, 101:02, 143:06), C10N20:04, C10N30:10, C10N40:04, C10N40:25

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 6 C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE APIPAT THE AMERICAN PETROLEUM INSTITUTE, NEW YORK, NY, US CS-A-272467, 29 October 1991, KLUCHO P 'LUBRICATING OIL FOR STOMATOLOGIC INSTRUMENTS' see abstract	1-7, 10, 12, 13
A	FR,A,2 687 165 (ESSO SOCIETE ANONYME FRANCAISE) 13 August 1993 see page 4, line 31; claims 1,8	1,6-11
X	US,A,5 154 840 (D.A.DRAKE) 13 October 1992 see column 2, line 11 - line 13 see column 3, line 51 - line 59 --- -/-	1,3-7,9, 10

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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